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3. If there be tangent hyperspheres in the regions β and γ, the following must hold:

$$-x_1 = x_2 = x_3 = -x_4 = -x_5 = R,$$

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and

$$R = \frac{4H}{V_2 + V_3 - (V_1 + V_4 + V_5)} \text{ in } \beta, \tag{4}$$

$$R = \frac{4H}{V_2 + V_3 + V_4 - (V_1 + V_5)} \text{ in } \gamma. \tag{5}$$

The value of R is now dependent on whether the sum of two cells of a pentahedroid is less than, equal to or greater than the sum of the other three cells. Thus if $V_2 + V_3 - (V_1 + V_4 + V_5)$ is negative in (4) then $V_1 + V_4 + V_5 - (V_2 + V_3)$ in (5) will be positive giving a positive R in γ for a negative value of R in β. Thus the number of tangent hyperspheres in the regions β and γ together will always be ten unless some of these expressions happen to be zero.

4. Finally when the center of the tangent hypersphere lies within the region δ,

$$-x_1 = x_2 = x_3 = x_4 = x_5 = R,$$

$$R = \frac{4H}{V_2 + V_3 + V_4 + V_5 - V_1}. \tag{6}$$

As the sum of any four cells of a pentahedroid is greater than the fifth, (6) gives a single positive value for R and hence there is one hypersphere tangent to the cells with its center in the region δ. There are five such hyperspheres, one in each of the five regions of the type δ.

Thus we have one tangent hypersphere within the pentahedroid, ten within the regions β and γ taken together and five in the regions δ, making the number of tangent hyperspheres equal in general to sixteen.

BOOK REVIEWS.

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Plane and Solid Geometry. By Webster Wells and Walter W. Hart. D. C. Heath and Company, Boston, 1916. viii + 467 pages.

It is very important that the introduction to a course in plane geometry should be well done. With inexperienced teachers, at least, the introduction to the course will usually be the one that is given in the text. The introductory chapter of a geometry may be expected to make a clear statement of certain definitions and assumptions and to illustrate them; to offer some suggestions that will tend to make the students feel a need for geometry; and to show the need of formal proofs and to give an introduction to them. In the present text the definitions are well illustrated with simple exercises. Not much is done in the introduction to show the uses of geometry. More exercises in construction would make the introduction more interesting and more effective in fixing new ideas.

The following sentences from the preface suggest the attitude of the authors in the selection and the arrangement of material: "In each Book, the fundamentally important theorems are given first. These theorems present a *safe and sane minimum course.* These are followed in each Book by one or more groups of theorems or applications which are strictly supplementary—material which has either long appeared in geometries in some form or has been introduced in recent years to add to the pupils' interest."

Care has been taken to make the book teachable. Teachers examining this text will be interested in the summaries such as appear on pages 27, 62, and 113; in the references to supplementary exercises in the footnotes; in the treatment of loci and inequalities; and in the suggested proofs which are left for the students to finish. The exercises are numerous and appear to be well graded. There is a table of trigonometric ratios and some problems applying them.

Certain definitions need revision. The definition of a circle given in § 16 is: "A circle is a closed curve all points of which are equidistant from a point within called the center." The circle need not be a plane figure by this definition. The definition of ratio, § 212, reads as follows: "The ratio of two magnitudes of the same kind is the quotient of their numerical measures in terms of a common measure." It seems likely that students will be confused by this definition. The following definition of the limit of a variable is given in § 401: "A limit of a variable is a constant such that the numerical value of the difference between the constant and the variable becomes and remains less than any small positive number." The "small positive number" must of course be pre-assigned.

In three important respects the book has departed little from the traditional. The exercises are mainly formal, with a comparatively small number of applications; not much has been done in applying algebra to the solution of geometric problems; and the notions of motion and symmetry, which are useful and which have become prominent in the teaching of elementary geometry in recent years, have received slight attention.

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Fundamental Conceptions of Modern Mathematics: Variables and Quantities, with a Discussion of the General Conception of the Functional Relation. By ROBERT T. RICHARDSON and EDWARD H. LANDIS. Chicago and London, The Open Court Publishing Co., 1916.

In their preface the authors describe their work as "essentially one of constructive criticism . . . the first attempt made on any extensive scale to examine critically the fundamental conceptions of mathematics as embodied in the current definitions." The present volume, which is to be followed by a second, is concerned with variables and quantities.